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FASCINATING

Fish facts

The biology and physiology of fish

FISH ARE fundamentally unique.

First of all, fish live in water—either fresh, salty or brackish (a little of both). People and many other animals live on land. To move on land, people walk on their legs. In the water, fish use their fins. Fish have several different kinds of fins, and each has a different function in helping it move through the water.

Before telling what each fin does, it's important to know where they are on the fish's body. A fish's dorsal fin or fins (some fish have more than one) is found on the center of a fish's back. Its anal fins are found on its underside (ventral side) near the tail. The pectoral fins (lateral, or side) are found behind the gills, at about where the shoulders of a person are if the fish were held upright. The pelvic fins (side fins) are found on the belly, in front of the anal fins. The largest fin of the fish, the caudal fin, is the fish's tail. A fish can move all its fins separately, giving it the ability to move quickly in any direction. Coordinating all these fins might seem tricky but to a fish, it comes naturally.

Serving as stabilizers, the fish's dorsal, anal and pelvic fins help the fish stay level in the water and keep it from rolling. The pelvic fins are also used for changing direction and for braking. Large pelvic fins on bottom-dwelling fish can also help them shuffle along the bottom. The pectoral fins act mostly as rudders and hydroplanes to control yaw and pitch. They also help the fish brake by causing drag. The caudal, or tail fin of the fish, is used to propel the fish forward and to help it steer. Muscles attached to the vertebrae of the fish's backbone contract to make the tail move from side to side in a wavelike fashion and thrust the fish through the water.

Shaped for swimming

Besides its fins, the shape of a fish also helps it glide more easily through water. Not all fish are shaped alike though. Fish have several main body shapes.

"Typical" fish, such as salmon, trout, barracuda and tuna are *fusiform,* or torpedo-shaped. Their bodies are compressed at the sides and taper more at the tail than at the head. In rivers, this shape helps a fish swim against strong river currents. An added hump on the back, such as that found on the humpback chub, also helps stabilize a fish in fast moving water. In open water, with little cover for hiding, this shape gives the fish the speed it needs to out-swim predators. A forked tail in some torpedo-shaped fish increases their speed even more. Oval-shaped fish like the northern pike can put on bursts of speed for short distances. They can also maneuver well around rocks and weeds.

Rays, skates, flounder and sole, which lurk on the bottom, are flat, or compressed, allowing them to hide better in the sand. Lamprey's, needlefish and eels are extra long and narrow. They swim with a slithering, serpentine motion, like a snake. Butterfly fish and angelfish are compressed from side to side like a pancake. The porcupine fish is an example of a round-shaped fish, and the cutlass is a ribbon-shaped fish, long and narrow but flattened sideways too. Catfish and suckers have a rounded body but with a flat underside that allows them to rest on the bottom and be less conspicuous. And some oddballs like the sea horse have bodies with shapes that are just too hard to describe.

Let there be air!

Most fish also have an air-filled swim bladder in their body that helps them suspend themselves in the water. Like a hot-air balloon, a fish's swim bladder fills with air and lets the fish maintain buoyancy in the water. A fish can change the amount of air in its swim bladder depending on the depth at which it wants to swim. The air in a fish's swim bladder is mostly oxygen. Getting oxygen in and out of the swim bladder involves a complex chemical process that counteracts diffusion. People don't have swim bladders, as you may have discovered in a swimming pool. Like you, a fish would have to use a lot of energy to avoid sinking to the bottom if it didn't have a swim bladder to help it float. Other organs you'll find inside a fish's body are similar to the one's we have: a heart to pump blood, a stomach and intestines to digest food and absorb it, a liver, a kidney and bladder, reproductive organs (gonads) and a brain and spinal cord running down its backbone.

What about lungs? Fish don't have lungs for breathing. Instead, they use gills to "breath." As a fish swims, water flows into its mouth and over the gills. Through *diffusion,* oxygen dissolved in the water enters the fish's blood through the capillaries (fine blood vessels) inside its gills. During diffusion, molecules move from where they are higher in concentration to an area where they are lower in concentration, until an equal concentration is reached (equilibrium). As a fish uses up oxygen to move it muscles, levels of oxygen get lower in the fish's blood than in the water. Oxygen from the water then moves into the fish's blood. Imagine yourself breathing hard after running. If you were a fish, you would be moving your gill covers (*opercula*) in and out rapidly, pumping more water through your mouth and over your gills to get more oxygen.

Though there is dissolved oxygen in water, the concentration of oxygen in water is much less than the concentration in the air we breathe (about 5 ml/liter in surface waters versus 210 ml/liter). Because of this, fish must employ a system that concentrates the oxygen in the water. Fish do this with a counter-current diffusion system. In this system, blood in the fish flows through the filaments of the gills in a direction opposite to the direction the water flows over the gills. This creates a flow of blood that is always much lower in

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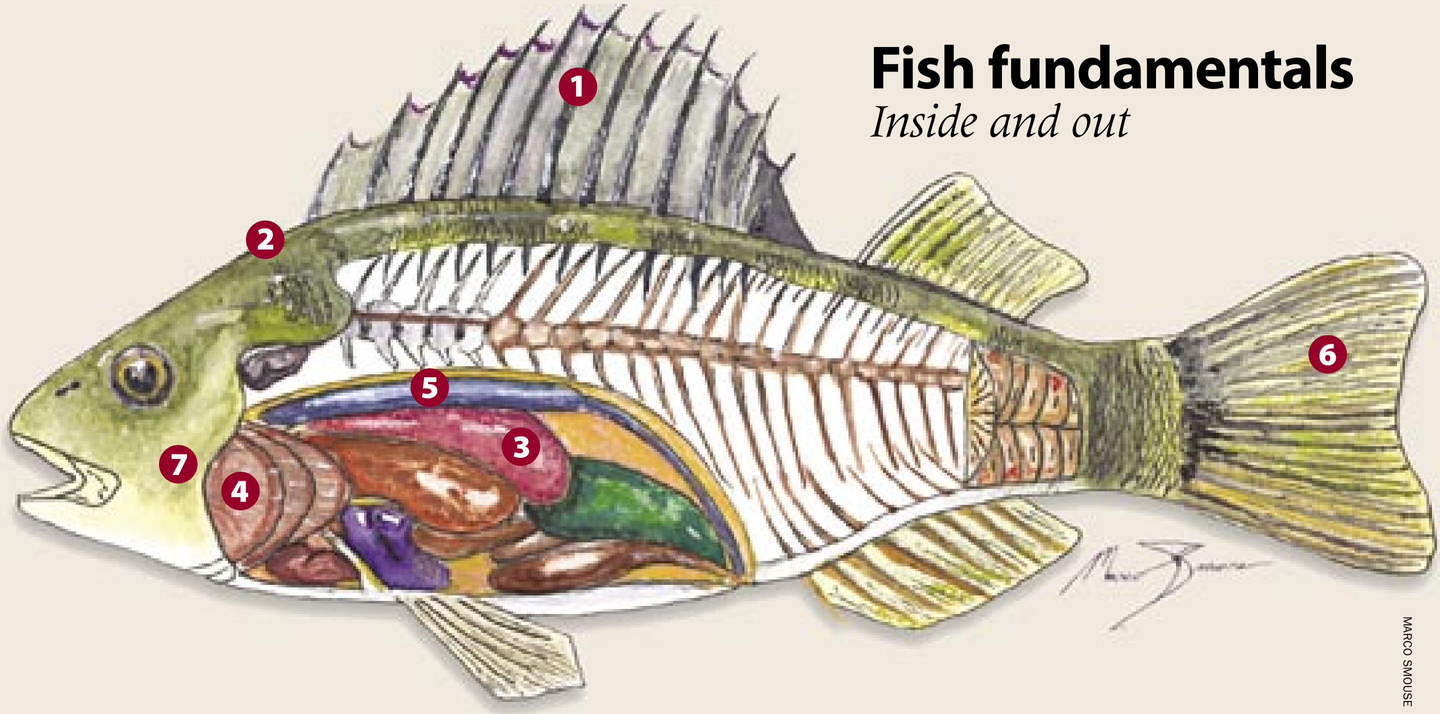
Fish fundamentals

Inside and out



MARCO SMOUSE

Matching activity

What are they for?

Match the fish structures listed at the right with what they do for the fish. Place the letter of the correct choice in the space in front of the fish structure.

_____ 1. Dorsal fin

_____ 2. Scales

_____ 3. Heart

_____ 4. Gills

_____ 5. Swim bladder

_____ 6. Caudal fin

_____ 7. Opercula

a. Pumps the fish's blood
b. Cover the fish's gills
c. Protect the fish's body
d. Stabilizes the fish and keeps it from rolling
e. Helps the fish stay buoyant in the water
f. Propels the fish forward
g. Absorb oxygen from the water

Answers to matching activity: 1) d; 2) c; 3) a; 4) g; 5) e; 6) f; 7) b.

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oxygen than the water coming in, which keeps the diffusion going. This opposite flow system makes a fish 80 to 90 percent efficient at absorbing oxygen from the water. If the blood flowed in the same direction as the water passing it, the blood would only take in half of the available oxygen from the water because equilibrium would be reached and diffusion would stop.

The skinny on fish skin

The bodies of most fish are covered with overlapping scales that protect their bodies like the shingles on a roof. In some species the scales have developed into bony plates. In others, such as the eel, they are very tiny. Some fish, like the catfish, have practically none. Scales themselves come in a variety of shapes, including: granoid (rhombic-shaped and covered with an enamel-like layer), cycloid (almost circular with smooth edges—the most common), ctenoid (round with serrate or combed edges) and placoid (with torpedo-like pointed ends).

A fish only develops scales during its first year of life. As it gets older, it doesn't grow more scales, its scales just get bigger. Fish and scale growth slows in the winter and speeds up in the summer. This causes rings to develop, like the rings you can see on a cross-section of a tree trunk. You can look at the rings on the scale of a fish, with a magnifying lens, to see how old the fish is.

A fish's scales are covered by its outer skin (epidermis). This thin layer of skin contains cells that secrete a slippery mucous layer that covers the fish's entire body. This mucous layer protects the fish from harmful bacteria, parasites and toxins that may be in the water. Touching a fish's body can damage the fish's protective coating. The mucous also helps fish move through the water with less friction.

The skin covering the fish's scales also contains the pigment cells that give a fish its color. Pigment cells that produce true colors are called *chromatophores.* Cells in the skin that produce chemicals which make certain fish shimmer, such as shiners and shad, are called *iridocytes.*

Fish happen to be among the world's most colorful creatures. Why are they colored in so many ways? Color in fish, like other animals, can serve as camouflage, concealment, a disguise, a warning to would-be predators or advertisement to potential mates. The spawning process in some fish, such as salmon, trout, sticklebacks and darters, triggers the chromatophores to activate, turning the male fish very bright and colorful. Fish under stress are often pale and discolored as they direct their energy into more important functions.

Certain patterns of stripes, bars, spots, patches and blotches often serve as disruptive markings that break up the outline of the fish or make it look less visible. Fish, for example, that live in weeds generally have vertical bars or stripes. Dark lines running through the eyes and *ocelli* (false eye spots) may keep other fish from recognizing where a fish is looking. An eye spot on a fish's tail might allow it to escape more easily as a predator lunges for its tail, instead of its head. Bright, bold colors often warn predators that a potential meal may be venomous or taste bad. One example is the showy and beautiful lionfish, which is extremely venomous. Most venomous fish deliver their venom via sharp spines.

Some fish can also change their hues to match the color of their surroundings. Some fish can change their stripes to spots. And others may have flaps or irregular outlines that help them blend in, or have appendages that look like the vegetation in which they live.

Another common method of concealment in fish is counter-shading. Counter-shading is where the fish's color is lighter on the belly than on the back. Many such species have black, blue or greenish backs and silvery undersides. Fish with counter-shading tend to live in open waters where, from below, the fish is difficult to see against the water's surface lit by the sun or moon. Other fish living in open water, including striped bass, have horizontal stripes and bars.

Some marine fish are even able to produce light through *bioluminescence.* Some bioluminescent fish actually have cells called *photophores* that can emit light. Others have symbiotic bioluminescent bacteria living on them. Some fish use their bioluminescence to attract prey, while others use this light to attract mates.

Fish, as you now know, are fundamentally fascinating!

Getting WILD!

Utah's WILD Notebook is produced by Utah's Project WILD program. (Note: this feature has replaced *Project WILD's Growing WILD /Nature's Call publication.*) WILD workshops, offered by the Utah Division of Wildlife Resources, provide teachers and other educators with opportunities for professional development and a wealth of wildlife education activities and materials for helping students learn about wildlife and its conservation. For a current listing of Project WILD educator workshops, visit the Project WILD Web site at *wildlife.utah.gov/projectwild* or e-mail *dianavos@utah.gov.*

WILD About Reading — books for learning more:

Peterson Field Guides: Freshwater Fishes by Lawrence M. Page and Brooks M. Burr, Houghton Mifflin, 1991.

Peterson First Guide to Fishes of North America by Michael Filisky, Houghton Mifflin, 1998.

Crinkleroot's 25 Fish Every Child Should Know by Jim Arnosky, Simon and Schuster, 1993.

Freshwater Fish and Fishing by Jim Arnosky, Four Winds Press, 1982.

About Fish: A Guide for Children by Catheryn P. Sill, Peachtree Publishers, 2002.

Fish by Steve Parker, Eyewitness Books, Knopf Publishing, 1990.

What Is a Fish? by Allison Larin and Bobbie Kalman, Crabtree Publishers, 1998.

It's WILD!

Project WILD activities for teachers and students that correlate to this topic include:

- Fashion a Fish
- Fishy Who's Who
- Color Crazy *(focus on fish)*
- Interview a Spider *(focus on fish)*

WILD educator resources and happenings

Utah fish posters: Contact Project WILD for information

Interactive Fish ID Flashcards: Excellent fish education Web site — *http://www.cnr.colostate.edu/~brett/fw300/flashcrd/*

FISH: Wonderful Web site for educators and kids with a wealth of activities and more — *www.geocities.com/Athens/Atrum/5924/fishclassification.htm*

A Quick Course in Icthyology: Great Internet resource with lots of information — www.marinebiology.org/fish.htm

Fish Videos for checkout from Project WILD: (Available for Project WILD-trained educators only)

- Bill Nye The Science Guy: Fish
- Fascinating Fishes
- Fish: Eyewitness Video

WILD About ELK: Advanced Project WILD Educator Training, June 18–19, 2004. Details and registration form on Project WILD Web site.